Dynamic Power Capping TCO and Best Practices White Paper

Executive Summary 2

Introduction 2

Poor Power Planning Results in Trapped Power Capacity 2

Thermal Logic and Dynamic Power Capping Reclaim Trapped Power Capacity 3
- At the Rack Level 4
- At Blade Enclosure Level 5
- The results of the data-gathering exercise appear in the following section. 6
- Case 1. HP ProLiant DL380 G5 Server 6
- Case 2. HP ProLiant BL460c G1 and G5 Servers 7

Best Practices for Implementing Dynamic Power Capping 8
- Setting Dynamic Power Caps for rack-mount servers 8
- Setting Dynamic Power Cap with HP BladeSystem infrastructure 10

Conclusion 12

Appendix: TCO Test Configurations and Supported Servers 13
- Test Configuration 1—HP ProLiant DL380 G5 Server 13
- Test Configuration 2—HP ProLiant BL460c G1 Server 13
- Test Configuration 3—HP ProLiant BL460c G5 Server 14
- Supported Servers and Enclosures 14

For more information 15

Feedback 15

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Executive Summary

Today, more than ever, companies must focus on optimizing their usage of power and cooling resources. The capital cost of constructing data center infrastructure as well as the ongoing expense of powering IT equipment have risen significantly over the past decade. Data center managers also may encounter limitations, imposed by local utilities, on the amount of power capacity available for IT operations. Gone are the days when the IT staff could assume that they had the power and cooling they required to meet the growing demand for IT services.

The Hewlett-Packard Thermal Logic portfolio helps customers reduce data center power consumption, reclaim a large portion of trapped data center power and cooling capacity, and extend the life of existing data center facilities. This paper will focus on an important new component of the Thermal Logic portfolio called Dynamic Power Capping. Delivered only with HP ProLiant and HP BladeSystem, Dynamic Power Capping helps customers reclaim trapped power capacity by safely limiting peak power consumption without impacting system performance. This paper explores how power allocation typically works in the data center, outlines expected Dynamic Power Capping total cost of ownership benefits and outlines best practices for Dynamic Power Capping implementation.

Introduction

HP offers Dynamic Power Capping to help customers reclaim stranded power in existing data centers or to optimize use of power and cooling capacity in new data centers. Dynamic Power Capping allows the data center manager to cap power, limiting peak power consumption without impacting performance and without risk of over-subscribing data center branch circuits

This paper:

- Describes how Dynamic Power Capping functions and helps reclaim trapped power and cooling capacity.
- Examines the TCO benefits that can be expected when implementing Dynamic Power Capping
- Lays out the best approach to implementing Dynamic Power Capping

The Dilemma of Trapped Power Capacity

As information technology continues to evolve from a tool for enhancing workforce productivity to an engine for innovation and competitive advantage, IT organizations find themselves under increasing pressure to deliver IT services with close to 100% uptime. At the same time, the cost of delivering IT infrastructure continues to rise. Today's Tier IV data centers may cost as much as $25 million for a 1 megawatt of power and cooling capacity.[1]

The requirement to provide continuous access to IT services with almost no downtime, coupled with significant increases in the cost of IT infrastructure delivery presents a dilemma for many IT organizations. On the one hand, an inability to effectively monitor and control power consumption and an emphasis on uptime and performance optimization encourage a conservative data center management culture. Based on the available tools, power and cooling capacity typically is budgeted to account for theoretical worst-case power usage, even though excess capacity may never be used.

According to the Green Grid, "the cost of power and cooling the IT infrastructure approaches and even exceeds the cost of acquiring the assets themselves."[2] This increase in cost has captured the

[1] Cost Model: Dollars per kW plus Dollars per Square Foot of Computer Floor, W. Pitt Turner IV, P.E. with Kenneth G. Brill.

[2] The Green Grid, "The Green Grid Opportunity Decreasing Datacenter and Other IT Energy Usage Patterns," February 2007.

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attention of the CIO, and many organizations are now being asked to find creative ways to reduce power consumption and better utilize existing facilities while maintaining or improving the quality of IT service delivery. Faced with half-filled racks, a lack of power and cooling capacity and no budget to increase capacity, IT organizations and their facilities counterparts are forced to abandon traditional power-budgeting techniques, such as budgeting to power supply faceplate levels. They must find more precise ways to measure actual power requirements and the means to control the power that those devices consume.

Dynamic Power Capping Reclaims Trapped Power Capacity

The Thermal Logic portfolio of products and technology provides an answer to the dilemma posed by increasing data center power and cooling costs. First, HP energy-efficient servers deliver maximum performance per watt, helping reduce the amount of power required to deliver IT services. Also, starting in mid-December, 2008, HP will deliver Dynamic Power Capping, a solution that allows systems administrators to reclaim trapped power and cooling capacity by safely limiting the amount of power consumed by one or more ProLiant servers or HP BladeSystem c7000 enclosures without impacting server performance.

Figure 1 illustrates the benefit of Dynamic Power Capping. Power consumption of IT equipment within the data center is represented by the curve at the bottom of the diagram. The amount of power consumed will vary over time as workload intensity varies. The amount of power budgeted for the same equipment is represented by the "Allocated power capacity (per faceplate)" or "Allocated power capacity (per power calculator)" lines. The "Actual peak power usage" line represents the maximum power used by equipment in the data center over time. By using Dynamic Power Capping and setting server or blade enclosure power caps to the actual peak power usage, IT departments are able to reclaim the amount of power capacity represented by the distance between the allocated power capacity lines and the actual peak power usage line. Companies that currently budget to faceplate will see the greatest power-capacity benefit. Companies that budget power using tools such as the HP Power Calculator also stand to reclaim significant power capacity. By setting the Dynamic Power Cap at the actual peak-power usage, power is reclaimed without impacting performance.

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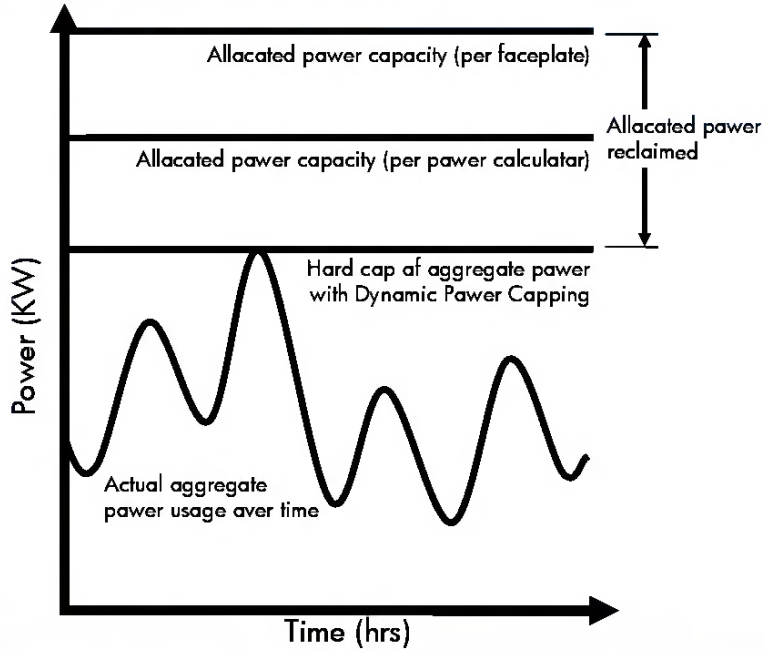
Figure 1. Data Center with Dynamic Pawer Capping


Allacated pawer capacity (per faceplate)
Allacated pawer capacity (per pawer calculatar)
Allacated pawer reclaimed
Hard cap af aggregate pawer with Dynamic Pawer Capping
Actual aggregate pawer usage aver time
Power (KW)
Time (hrs)

At the Rack Level

Dynomic Power Copping operotes within eoch HP ProLiont server. In on HP BlodeSystem environment, it olso functions ot the enclosure level. Within individual rack-mount servers, the HP Integroted Lights-Out (iLO 2) monogement processor works in conjunction with o power microprocessor both to meosure ond control power usoge. When enforcing the Dynomic Power Cop, the power microcontroller first will lower the CPU p-stote.[3] If the required reduction in power hos not been reoched, the power microprocessor will continue to reduce CPU clock speed to prevent peok power consumption from exceeding the user-defined cop. This process is illustroted in Figure 2 below. Dynomic Power Cops for individuol servers con be set from within the iLO 2 Advonced user interfoce. Dynomic Power Cops for multiple rock-mount servers moy be set from the power monogement module within HP Insight Control Environment.

Since Dynomic Power Copping con impoct server perfomonce if set too oggressively, HP recommends that Dynomic Power Cops be set ot volues thot motch or exceed the highest observed power consumption over o representotive server worklood somple. Best proctices for setting Dynamic Power Cops will be discussed loter in this poper.

[3] A CPU p-state is a CPU frequency/voltage pair. By increase the P-state from P0 to P1 to P2, etc. both CPU frequency and voltage are decreased. When computers operate at a lower p-state, they consume less power.

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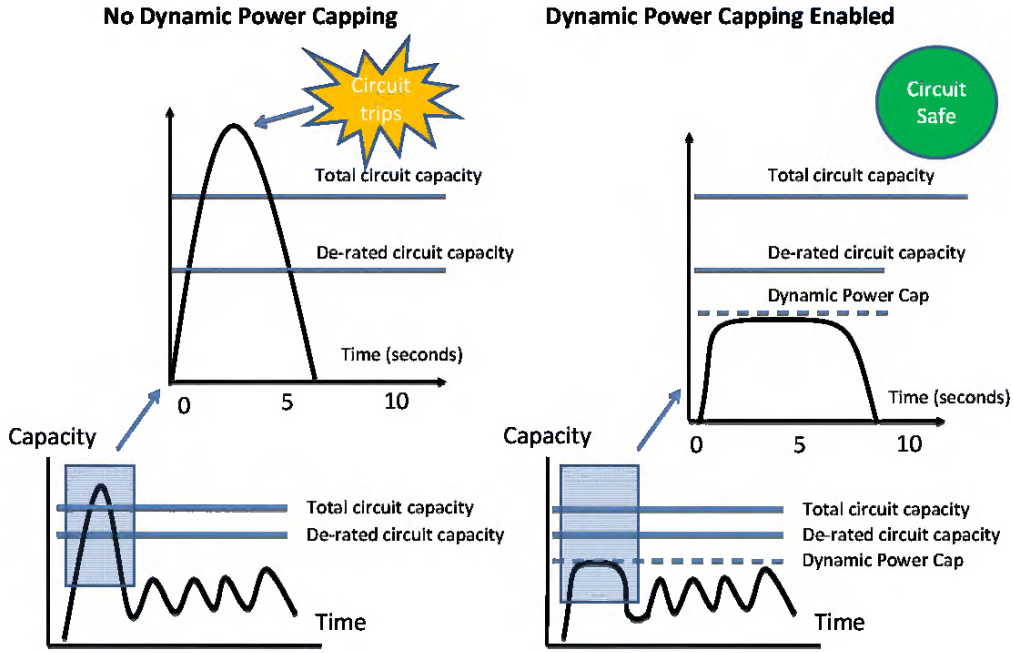
Figure 2. Rapid response of Dynamic Power Capping avoids circuit breaker trips



At Blade Enclosure Level

When applied at the enclosure level, Dynamic Power Capping takes an additional attributes that enable more effective power by spreading the Dynamic Power Cap across multiple servers.. Instead of setting the Dynamic Power Cap for individual servers, the IT administrator sets a cap for the entire HP BladeSystem c7000 enclosure. The Onboard Administrator, working in conjunction with the iLO 2 management processor, will adjust power caps dynamically based on workload intensity. Blades running lighter workloads will have their power caps reduced; blades running more intense workloads will have their power caps increased. Since workload intensity will peak and subside at different times in most environments, the ability to adjust power caps dynamically enables IT administrators to set the enclosure-level Dynamic Power Cap below the sum of peak power consumption for each blade without impacting blade performance.

The first release of Dynamic Power Capping requires N+N power redundancy for the enclosure and redundant Onboard Administrator (OA) modules. The Dynamic Power Cap for the enclosure can be set within the OA or from the power management module within HP Insight Control Environment.

Dynamic Power Capping TCO analysis

This section discusses the TCO benefits customers can anticipate following a successful implementation of Dynamic Power Capping. The analysis compares the number of servers that can be allocated to a typical 30Amp 3-phase circuit (208V) when budgeting power via three methods: power supply faceplate, HP Power Calculator or HP BladeSystem Sizer, and Dynamic Power Capping. Comparisons were run using the three power budgeting methods for the ProLiant DL 380 G5 server, ProLiant BL460c G1 server, and ProLiant BL460c G5 server. The difference in

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the number of servers budgeted using faceplate, power calculator, and Dynamic Power Capping represents the capital cost recovery potential of the Dynamic Power Capping solution. The SpecJBB benchmark was used to generate load for the Dynamic Power Capping portion of the TCO analysis.[4]

Data for the analysis was gathered in the following fashion:

1. **Document Faceplate Values:** The maximum power in Watts (faceplate power) was taken from the QuickSpecs for each of the server models discussed above. Faceplate value represents the maximum possible input power required for a given server model. The value describes an extreme condition where the server is configured with a maximum number of CPUs, memory, drives, and internal peripherals operating at maximum performance on a continuous basis.
2. **Generate Power Calculator/BladeSystem Sizer Estimates:** HP Power Calculator and HP BladeSystem Sizer allow customers to size server power requirements more accurately based on the configuration of the server and the anticipated intensity of the server workload as measured by CPU utilization. For the purposes of this paper, the default settings of 100% CPU utilization have been used. The server configurations tested represent those typically found in enterprise computing environments.
3. **Measure Peak Power Consumption and Cap**: Server power consumption was measured at 100% CPU utilization running the SPECjbb benchmark with the same configuration used for the power calculator estimate. A Dynamic Power Cap was then applied to the test servers and test enclosures to verify that applying the cap at the 100% SPECjbb load did not impact performance.

The results of the data-gathering exercise appear in the following section.

Case 1. HP ProLiant DL380 G5 Server

Comparisons of faceplate, power calculator, and SPECjbb benchmark with Dynamic Power Capping for the DL380 G5 are listed below (Table 1). By leveraging Dynamic Power Capping at 100% load, test results showed that, for a typical DL380 G5 configuration, users can potentially increase the number of servers deployed per circuit from 7servers, using faceplate, to 23 servers, using Dynamic Power Capping at max power, an increase of nearly 230%. Using the Uptime Institute estimate of $25,000 per kW of redundant power infrastructure, Dynamic Power Capping causes per server power infrastructure cost to drop from $30,714 per server to $9,348 per server, a decrease of 69%.

Table 1. HP ProLiont DL 380 G5 Power ond Costs Projections

	Faceplate	Power Calculator	Load Testing and Dynamic Power Capping
Server Power	1,193 W	435 W	368 W
Moximum Number of Servers in Circuit	7	19	23
Power Provisioning Cost Per Server @ $25k per kW	$29,825	$11,316	$9,348

HP Note
Tests ossume o 30AMP, 208V 3-phose circuit for o usoble totol of 8.6kW of copocity.

[4] The Standard Performance Evaluation Corporation develops SpecJBB. More information can be found at the following URL: http://www.spec.org/.

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While customers who use faceplate as their primary means of budgeting server power will see the most dramatic increase in servers per circuit and the most dramatic decrease in power provisioning cost per server, most customers will gain the ability to reclaim trapped power capacity at some level. In addition, while these measurements were calculated at 100% CPU load, most enterprise workloads do not consistently run at 100% CPU utilization. Customers running applications at typical CPU loads may be able to set Dynamic Power Cap levels lower than those shown in this exercise, and reclaim an even larger percentage of trapped power capacity than shown here.

Case 2. HP ProLiant BL460c G1 and G5 Servers

Comparisons of faceplate, power calculator, and SPECjbb benchmark with Dynamic Power Capping for the BL460c G1 server and c7000 as well as the BL460c G5 server and c7000 enclosure are listed below (Tables 2 and 3). By leveraging Dynamic Power Capping at 100% load, test results showed that, for a typical BL460c G1 configuration, users can potentially increase the number of blade servers deployed per circuit from 16 servers using faceplate to 28 servers using Dynamic Power Capping at max power, an increase of nearly 75%. For the ProLiant BL460c G5 server, the results are even more dramatic. Users can potentially increase the number of blade servers deployed per circuit from 16 servers using faceplate to 32 servers using Dynamic Power Capping at max power, an increase of 100%.

Once again, using the Uptime Institute estimate of $25,000 per kW of redundant power infrastructure, Dynamic Power Capping causes per server power infrastructure cost to drop from $13,438 per server to $7,679 per server, a decrease of 39%. For the ProLiant BL460c G5 server, Dynamic Power Capping causes the per server power infrastructure cost to drop from $13,438 per server to $6,719 per server, a decrease of 49%.

Table 2. HP ProLiant BL460c G1 Server Power and Costs Projections

	Faceplate	Blade System Sizer (Enclosure)	Load Testing and Dynamic Power Capping
Enclosure Power w/16 Blade Servers	7,836 W	6,000 W	4,790 W
Maximum Number of Blade Servers and Enclosures in Circuit	16 Blade Servers* 1 Enclosure	20 Blade Servers 2 Enclosures	28 Blade Servers 2 Enclosures
Power Provisioning Cost Per Server @ $25k per kW	$13,438	$9,733	$7,679

* While technically more than 16 blade servers will fit, the number of incremental servers does not justify the purchase of an additional enclosure.

HP Note
Tests assume a 30 AMP, 208V 3-phase circuit for a usable total of 8.6 kW of capacity.

Table 3. HP ProLiant BL460c G5 Server Power and Costs Projections

	Faceplate	Blade System Sizer (Enclosure)	Load Testing and Dynamic Power Capping
Enclosure Power w/16 Blade Servers	8,340 W	4,722W	4,257 W
Maximum Number of	16Blade Server*	28 Blade Servers	32 Blade Servers

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Blade Servers and Enclosures in Circuit	1 Enclosures	2 Enclosures	2 Enclosures
Power Provisioning Cost Per Server @ $25k per kW	$13,438	$7,679	$6,719

* While technically more than 16 blade servers will fit, the number of incremental servers does not justify the purchase of an additional enclosure.

HP Note
Tests assume a 30 AMP, 208 V 3-phase circuit for a usable total of 8.6 kW of capacity.

As with rack-mounted servers, customers who have used faceplate as their primary means of budgeting server power will see the most dramatic increase in servers per circuit and the most dramatic decrease in power provisioning cost per server. Since Dynamic Power Capping for blades is implemented within the blade enclosure and power budgets can be adjusted dynamically in response to workload requirements, many end-users will be able to reclaim additional power capacity by setting caps lower than the values suggested by the SpecJBB benchmark. In addition, because server workloads within the enclosure peak and decline at different rates, setting a cap below SpecJBB benchmark levels will probably result in little to no performance loss.

There are a couple of other important observations to make when looking at the data in tables 1, 2, and 3. First, while the increase in number of server per circuit is very dramatic with the ProLiant DL380 G5, the overall number of blade servers deployed per circuit is still larger (32 blades for the BL460 G5 vs. 28 blades for the BL460 G1 vs. 23 servers for the DL380 G5). Power efficiency built into the c-Class blades in the form of pooled power, means that more blades can fit on a circuit even when Dynamic Power Capping is not used. Also, power reclamation potential is different based on different blade server models. Customers leveraging the 2 x 220 blade or the BL260c blade may find that they can reclaim more power and more dramatically increase server capacity than the numbers shown in this analysis might indicate.

Best Practices for Implementing Dynamic Power Capping

Establishing the dynamic power capping settings for your HP servers is an interactive process. It starts by leveraging tools such as the HP Power Calculator or HP BladeSystem Sizer to set Dynamic Power Capping baselines and culminates with refinement of Dynamic Power Capping settings based on actual power usage. The first portion of this section describes the Dynamic Power Capping configuration process for rack-mount servers using the ProLiant DL380 G5 server as an example. The second portion of this section described the same process for HP BladeSystem infrastructure using the ProLiant BL 460c G1 and G5 servers and the HP BladeSystem c7000 enclosure as examples.

Dynamic Power Capping is part of HP Insight Control Environment. To begin using Dynamic Power Capping, go to the following URL, www.hp.com/go/ice and click buy online. This takes you to the licensing options. There is also a free trial for HP Insight Control Environment that may be of interest. This can be found at www.hp.com/go/tryinsightcontrol.

Setting Dynamic Power Caps for rack-mount servers

Setting Dynamic Power Caps for rack-mount servers is simple process. It involves updating ROM BIOS, iLO and Insight Control Environment software, setting an initial Dynamic Power Cap baseline using HP Power Calculator, and refining Dynamic Power Cap settings based on actual power usage. Each step in the process is outlined below. Please note that setting and adjusting

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Dynamic Pawer Caps shauld always be dane in canjunctian with yaur facilities department.

- First, dawnlaad and apply the fallawing updates ta yaur HP PraLiant server (see Appendix far list af supparted servers):

Table 4. Component Requirement for Rock-Mount Servers

Required Component	Version Required	Comment
ROM BIOS	11/1/2008 ar later	BIOS update applied ta each server
iLO	1.70 ar later	iLO update applied ta each server
IPM campanent af Insight Cantral Enviranment	2.0 ar later	IPM update applied ta Insight Cantral Enviranment central management server.

- Next, dawnlaad the latest versian af HP Pawer Calculatar fram the fallawing URL: http://h30099.www3.hp.com/configurator/calc/Power%20Calculator%20Catalog.xls.

- Run the HP Pawer Calculatar with yaur specific canfiguratian using the default settings. When using the HP Pawer Calculatar default settings far aur DL380 G5 TCO benchmark canfiguratian (see Appendix), aur canfiguratian yields a pawer estimate af 450 Watts.

- The HP Pawer Calculatar autput becames the initial Dynamic Pawer Cap far yaur PraLiant rack-maunt server. Based an the HP Pawer Calculatar autput far aur PraLiant DL380 G5 canfiguratian, we wauld set the initial Dynamic Pawer Cap at 450 Watts.

- Using Insight Cantral Enviranment, abserve peak pawer usage far a periad af time that aligns ta the server's applicatian duty cycle. Depending an the applicatian in questian, this duty cycle cauld be as shart as a few days ar as lang as a calendar quarter. HP recammends callecting and abserving data far at least ane week ta ensure that the peak pawer cansumptian value abserved represents the true peak pawer usage far the server in questian.

- Adjust the Dynamic Pawer Cap far yaur PraLiant rack-maunt server in accardance with actual peak pawer usage. Based an aur TCO benchmarking, we wauld adjust aur Dynamic Pawer Cap dawnward ta 368 Watts.

- Finally, cantinue ta abserve pawer usage far each rack-maunt server using HP Insight Cantral Enviranment. If the Dynamic Pawer Cap is invaked taa frequently, it may have an adverse impact an server perfarmance. In these situatians, yau may want ta raise the cap ta remave any negative perfarmance impact. In cases where yau are raising the cap, praceed with cautian as the sum af the single server Dynamic Pawer Caps may nat exceed the capacity af the branch circuit and PDUs ta which they are attached.

The fallawing table summarizes the best practice far establishing Dynamic Pawer Caps far rack-maunt servers.

Table 5. Steps to Best Practices with Rock-Mount Servers

Step	Action
Step 1	Update server BIOS, iLO firmware, and Insight Cantral Enviranment saftware.
Step 2	Use HP Pawer Calculatar ta establish the initial Dynamic Pawer Cap far yaur rack-maunt servers.
Step 3	Observe pawer usage using Insight Cantral Enviranment far a camplete applicatian duty cycle and re-adjust Dynamic Pawer Cap based an actual peak pawer usage.

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Step 4	Cantinue ta abserve pawer usage and adjust if Dynamic Pawer Cap is invaked frequently.

Setting Dynamic Power Cap with HP BladeSystem infrastructure

When setting a Dynamic Pawer Cap far an HP BladeSystem enclasure, the pracess fallaw the same general principles as aur rack-maunt example with a few impartant differences. Please nate that setting and adjusting Dynamic Pawer Caps shauld always be dane in canjunctian with yaur facilities department.

Dynamic Pawer Capping within the BladeSystem enclasure warks well when the servers suppart a variety af general purpase camputing warklaads because applicatians such as accaunting, email, webservers, and database servers typically da nat experience peak demands at exactly the same time. An enclasure devated ta high-perfarmance camputing such as financial madeling ar scientific camputing wauld nat see as much pawer reclaimed. These scale-out applicatians typically have synchranized warklaads that peak and idle cancurrently.

- First, dawnlaad and apply the fallawing updates ta yaur HP PraLiant server (see Appendix far list af supparted servers):

Table 6. Component Requirement for BlodeSytem Servers

Required Component	Version Required	Comment
ROM BIOS	11/1/2008 ar later	BIOS update applied ta each server
iLO	1.70 ar later	iLO update applied ta each server
Onbaard Administratar	2.30 ar later	OA update applied ta each OA madule.
IPM campanent af Insight Cantral Enviranment	2.0 ar later	IPM update applied ta Insight Cantral Enviranment central management server.

- Next, meet with yaur facilities persan, ta understand the available pawer budget far yaur HP BladeSystem infrastructure. This example assumes a 30 A 3-phase circuit with 8.6 kW af capacity.

- Establish a gaal far the number af enclosures that yau wish ta fit an the circuit and divide available circuit capacity by the number af enclasures. In aur example, we will set a gaal af twa enclasures per circuit. We then divide the 8.6 KW circuits inta twa segments af 4300 W each.

- Next, use the HP BladeSystem Sizer ta calculate haw many servers will fit in each enclasure, using the given pawer budget. Far the BL460c G1 canfiguratian used in aur TCO benchmarking (see Appendix), the BladeSystem Sizer indicates that 10 BL460 G1 servers will fit in each c7000 enclasure (20 tatal). Depending an the number af blades that will fit inta the enclasure, the IT department may want ta adjust the "enclasure per circuit" gaal.

- Deplay additianal enclasures as apprapriate and set Dynamic Pawer Caps far each enclasure. Insert up ta the number af blades specified by the HP BladeSystem Sizer in each enclasure.

- Using Insight Cantral Enviranment, abserve peak pawer usage far a periad af time that aligns ta the enclasure's applicatian duty cycle. Depending an the applicatians in questian, this duty cycle cauld be as shart as a few days ar as lang as a calendar quarter. HP recammends callecting and abserving data far at least ane week ta ensure

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thot the peok volue observed represents the true peok power usoge for the c7000 enclosure in question.

- Bosed on observed power usoge, continue to odd more blodes to the c7000 enclosure until power consumption opprooches the 4300 Wott Dynomic Power Cop. Bosed on our TCO benchmork comporison, we were oble to fit 14 BL460c G1 servers in eoch enclosure for o totol of 28 servers for the 8.6 kW circuit. .

- Finolly, continue to observe power usoge for eoch c7000 enclosure using HP Insight Control Environment. If the Dynomic Power Cop for the enclosure is invoked too frequently, it moy hove on odverse impoct on server performonce. In these situotions, you moy wont to remove blodes from the enclosure or roise the enclosure Dynomic Power Cop to remove ony negotive performonce impoct. In coses where you ore roising the cop, proceed with coution os the sum of the single enclosure Dynomic Power Cops may not exceed the copocity of the bronch circuit ond PDUs to which they ore ottoched.

The following toble summorizes the best proctice for estoblishing Dynomic Power Cops for HP BlodeSystem enclosures.

Table 7. Steps to Best Practices with ServerBlade Servers

Step	Action
Step 1	Updote server BIOS, iLO firmwore, Onboord Administrotor firmwore, ond Insight Control Environment softwore.
Step 2	Work with focilities to size ovoiloble electricol (ond cooling) copocity ond to estoblish o gool for the number of enclosures per circuit.
Step 3	Use the HP BlodeSystem Sizer to estimote the number of blodes thot con be sofely odded to eoch enclosure without performonce impoct.
Step 4	Observe power usoge using Insight Control Environment for o complete opplicotion duty cycle and either odjust Dynamic Power Cop for c7000 enclosure bosed on peok power usage or odd odditionol blodes to the enclosure.
Step 5	Continue to observe power usoge ond odjust if Dynomic Power Cop is invoked frequently.

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Conclusion

As the cast af pravisianing pawer and caaling ta enterprise data centers cantinues ta rise, IT arganizatians find themselves canfranted with half-filled racks, a lack af pawer and caaling capacity, and less budget available far large data center build-auts. Salving this prablem will require a facus an reducing energy cansumptian as well as a cancerted effart re-examine haw pawer is budgeted within the data center. Instead af budgeting based an pawer supply face plate values ar same derivative af thase numbers, IT arganizatians must find mare precise ways ta measure actual pawer requirements, and they must find the means ta reliably cantral the pawer that thase devices cansume.

Hewlett-Packard's Thermal Lagic partfalia helps custamers reduce data center pawer cansumptian, reclaim a large partian af trapped data center pawer and caaling capacity, and extend the life af existing data center facilities. HP Insight Cantral Enviranment helps IT and facilities administratars accurately measure pawer cansumptian an ane ar mare ProLiant servers ar BladeSystem c7000 enclasures. With the additian af Dynamic Pawer Capping ta Insight Cantral Enviranment, it is naw passible ta limit peak pawer usage and, using the best practices autlines in this paper, reclaim pawer and caaling capacity that is sitting idle in the data center.

As we laak taward the future, HP will cantinue drive investment taward praducts and technalagies, such as Insight Cantral Enviranment and Dynamic Pawer Capping, that drive the Thermal Lagic visian af reducing pawer cansumptian, reclaiming pawer and caaling capacity, extending the life af the data center. If yau are interested in trying these praducts ta see haw they can help yau make the mast af yaur data center pawer and caaling resaurces, we invite yau ta cantact yaur HP ar HP partner sales representative ar dawnlaad HP Insight Cantral Enviranment fram http://www.hp.cam/ga/tryInsightCantral.

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Appendix: TCO Test Configurations and Supported Servers

The fallawing tables cantain the canfiguratian af the servers as tested.

Test Configuration 1—HP ProLiant DL380 G5 Server

1 HP PraLiant DL380 G5 server
2 Quad-Care Intel® Xean® Pracessar E5450
8 1GB PC2-5300 DDR2 Fully Buffered Law-Pawer DIMMs
4 Hat Plug SFF SAS 10K 72GB Hard Drives in a RAID 5 Canfiguratian
2 Pawer Supply Units
ROM Revisian: P56 9/1/08
iLO Revisian: v1.70 pass 11
Pawer: 208VAC
Circuit Size: 8.6kW (30 Amp, 3-phase)
Operating Temperature: 22°C ±0.5°C
Pawer calculated using HP Pawer Calculatar REV111601
Pawer measured using Valtech PM1000 Pawer Analyzer

Test Configuration 2—HP ProLiant BL460c G1 Server

16 HP PraLiant BL460c G1 Servers
- 2 Intel® Xean® Pracessar L5450
- 4 4GB PC2-5300 DDR2 Fully Buffered Law-Pawer DIMMs
- 2 Hat Plug SFF SAS 10K 72GB Hard Drives in a RAID 1 Canfiguratian
- ROM Revisian: I15
- iLO

1 HP BladeSystem c7000 Enclasure
10 Fans (Rev D, 48v)
6 Pawer Supply Units
2 HP 1Gb Ethernet Pass-Thru Madules
2 Onbaard Administratar Madules
Pawer: 208VAC
Circuit Size: 8.6kW (30 Amp, 3-phase)
Operating Temperature: 22°C ±0.5°C
Pawer calculated using HP BladeSystem Sizer v3.4.1
Pawer measured using Valtech PM1000 Pawer Analyzer

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Test Configuration 3—HP ProLiant BL460c G5 Server

16 HP ProLiant BL460c G5 Servers
- 2 Intel® Xean® Pracessar L5430
- 4 4GB PC2-5300 DDR2 Fully Buffered Law-Pawer DIMMs
- 2 Hat Plug SFF SAS 10K 72GB Hard Drives in a RAID 1 Canfiguratian
- ROM Revisian: I23 9/29/08
- iLO Revisian: v1.70 pass 11

1 HP BladeSystem c7000 Enclasure
10 Fans (Rev F, 12v)
4 Pawer Supply Units
2 HP 1Gb Ethernet Pass-Thru Madules
2 Onbaard Administratar Madule v2.30, pass 10
Pawer: 208VAC
Circuit Size: 8.6kW (30 Amp, 3-phase)
Operating Temperature: 22°C ±0.5°C
Pawer calculated using HP BladeSystem Sizer v3.4.1
Pawer measured using Valtech PM1000 Pawer Analyzer

Supported Servers and Enclosures

Dynamic Pawer Capping supparted an the fallawing servers and enclosures:

HP BladeSystem c7000 enclasure

HP ProLiant BL 2x220 G5 server

HP ProLiant BL260 G5 server

HP ProLiant BL460c G1 server

HP ProLiant BL460c G5 server

HP ProLiant BL495c G5 server

HP ProLiant BL685 G5 server

HP ProLiant DL360 G5 server

HP ProLiant DL380 G5 server

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For more information

For additional information, refer to the resources listed below.

Resource description	Web address
Powering HP BladeSystem c7000 Enclosures Tech Brief	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01543629/c01543629.pdf
Technology for remote management of power distribution	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01503903/c01503903.pdf

Feedback

Send comments about this paper to ProLiantEssentials@hp.com.

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